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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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Drill bit system for drilling a bore hole

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DRILL BIT AND SYSTEM FOR DRILLING A BORE HOLE

The present invention relates to a drill bit for drilling a bore hole in an object, the drill bit comprising a bit body extending around a central longitudinal axis, the drill bit being operable by rotation about the central longitudinal axis.

An expandable drill bit is known and disclosed in published patent application GB 2 365 888 A. The known drill bit comprises two pivotable arms provided with cutters. In retracted position the arms cut a bore which clears the bit body, and in expanded position they cut a wider bore. In the expanded position a pilot section cuts the center of the bore hole, and the arms cut the gauge.

It is an object of the invention to improve the drill bit. In particular, it is an object of the invention to provide a drill bit that is more reliably switchable between its retracted and expanded positions.

According to the invention, there is provided a drill bit for drilling a bore hole in an object, the drill bit comprising a bit body extending around a central longitudinal axis, the drill bit being operable by rotation about the central longitudinal axis, the bit body comprising a central shank for connecting the drill bit to a drilling system, the drill bit further comprising a cutting arm provided with a set of cutters for cutting the object, the cutting arm being coupled to the bit body via pivot means via which the cutting arm is pivotable between a retracted position and an expanded position whereby at least in the expanded position the

set of cutters is in a cutting position with respect to the object whereby cutting action causes a rotational torque between the cutting arm and the central shank, which drill bit is in addition to the pivot means further provided with support means for transmitting at least part of said rotational torque from the cutting arm to the central shank.

By virtue of the provision of the support means, the pivot means is relieved from taking the full torque load. Thereby the pivoting means can be constructed less robustly, without loosing reliability of switching the drill bit from the retracted to the expanded position and vice versa.

More generally, the invention relates to a bore hole tool usable within a bore hole formed in an object.

In accordance with the invention, the bore hole tool comprises a tool body extending around a central longitudinal axis, the tool body comprising a central shank and a tool arm, the tool arm being coupled to the tool body via pivot means via which the tool arm is pivotable between a retracted position and an expanded position whereby at least in the expanded position the tool arm is arranged for transmitting a force from the central shank to the object, which bore hole tool is in addition to the pivot means further provided with support means for transmitting at least part of said force from the tool arm to the central shank.

In another aspect, the invention provides a hydraulic system for driving a pivoting movement of a pivotable tool arm between a retracted position and an expanded position, the hydraulic system comprising a cylinder and piston means slidably arranged in the cylinder forming a drive chamber on one side of the piston means and a

return chamber on the other side of the piston means, the piston means having a forward and a rearward position in the cylinder whereby the piston means is activatable to its rearward position by causing the drive force acting on the piston as a result of pressure in the drive chamber to exceed the return force acting on the piston as a result of pressure in the return chamber, which piston means is coupled to the pivotable tool arm for driving the tool arm from the retracted position to the expanded position when the piston is driven into its rearward position, whereby the piston means is coupled to gate means with is arranged such that the return force acting on the piston as a result of pressure in the return chamber exceeds the drive force acting on the piston as a result of pressure in the drive chamber when the piston means is in or near its forward position whereas the opposite is the case when the piston means is in a position other than in or near its forward position.

When the tool arm is in its retracted position, the piston means can be positioned in or near its forward position where the gate means is switched such as to bias the piston means to its forward position. When the piston means is mechanically moved out of its forward position, the gate means is switched because it is coupled to the piston means, which results in the drive force acting on the piston as a result of pressure in the drive chamber exceeding the return force acting on the piston as a result of pressure in the return chamber. Consequently, the tool arm is pivoted to its expanded position and held in that position by the piston means. The starting situation, whereby the piston means is again biased in its forward position can be restored by mechanically forcing the piston means to its forward position, or by

provision of additional gate means for regulating the pressures inside the drive chamber and return chamber such as to move the piston means forward on command.

The invention will be described hereinafter in more detail and by way of example with reference to the accompanying drawings in which:

Fig. 1 shows a schematic longitudinal section of a drill bit according to one embodiment of the invention in retracted position;

Fig. 2 shows a schematic longitudinal section of the drill bit of Fig. 1 in expanded position;

Fig. 3 shows a schematic cross section along line A-A' of the drill bit of Fig. 1 in expanded position.

In the Figures like reference numerals relate to like components.

Referring to Fig. 1, a longitudinal section of the drill bit is schematically depicted showing some components of the bit. It comprises a pilot section 1, with a cutting structure of a regular bit and a diameter D1, which is equal to the pass-through diameter of an entry part of the bore hole, for instance provided by a casing tube being present in the bore hole. The shank 2 of the bit is provided with a thread 3 to connect the construction to the drilling assembly. Cutting arms in the form of under-reaming arms 4 are connected to the shank of the bit via pivot means in the form of hinges 5 which are supported by two lips 6. The pilot section 1 is connected to the shank by a tube 7, which is equipped with a piston 8. The tube with piston can move axially relative to the shank.

The piston 8 separates two annular chambers in the shank. Chamber 10 below the piston is connected to the

bore of the tube 7 via a port 9. This port 9 is closable by the shank when the piston 8 is in the lower most position. The chamber 11 above the piston 8 is connected to a well bore annulus, formed between the drill bit body and the bore hole, via port 12. When a drilling fluid is circulated through the bit, the pressure drop across the nozzles causes a net upward force on the tube 7, because the annular piston area is larger than the area of the tube 7.

In case the two under-reaming arms 4 are symmetrical, the bit has a force balanced cutting structure for any position of the arms. The outer surface of the lips 6 of the shank can be provided with a wear resistant layer to provide additional lateral stabilisation of the bit.

When drilling an over gauge hole with a casing in an earth formation, the running procedure is as follows:

The bit is run through the casing with the under-reaming arms in retracted position as shown in Fig. 1 and into the open hole underneath the casing to enable the drilling assembly to be locked in the lower part of the casing. Then the casing with drilling assembly is run to the bottom of the hole. During this operation mud circulation is possible without activating the under-reaming arms 4 because the port 9 in tube 7 is closed by the shank when the piston is in lowest position. Once the pilot bit tags the bottom of the hole, the tube 7 is moving upwards relative to the shank and port 9 opens. The pressure drop across the bit nozzles will tend to close the bit. By closing the bit the under-reaming arms 4 will move outwards, and end up in their expanded position such as is schematically depicted in Fig. 2.

Still referring to Fig. 2, when the arms 4 are in fully expanded position the lips (6) of the shank 2 snap

around the flat sections 13 at the gauge of the pilot section 1. At the same time the lock-ring 14 at the lower end of the shank 2 snaps in the groove in the under-reaming arms 4. The lock-ring 14 and the grooves of the under-reaming arms can be teethed to prevent rotation of the arms 4 relative to the shank 2 in the direction of rotation of the bit.

Once the pilot bit is in its upward most position, resulting in the under-reaming arms 4 being in their fully expanded position, the drilling torque of the pilot bit is transmitted via the lips 6 to the shank 2 and subsequently to the drilling assembly via the threaded connection 3. The weight on the pilot bit 1 is transferred via the under-reaming arms 4 and the lock-ring 14 to the shank 2 and subsequently via the threaded connection 3 to the drilling assembly. The weight on the under-reaming arms 4 is transferred via the lock-ring 14 to the shank 2 and the torque of the under-reaming arms 4 is transferred via the teethed sections of the lock-ring 14 to the shank.

Thus, once the arms 4 are in expanded position the expansion mechanism is not exposed to the drilling loads which makes the bit very robust. In fact, the object experiences the expanded bit like a single piece solid bit body.

The drill bit can also be used to drill-out the previous casing shoe provided with a bell, or drilling-out of a previous casing shoe as part of conventional casing drilling operations.

In this case the procedure is as follows. After the drilling assembly is locked in the casing, the casing is run into the cased hole until the top of the cement is tagged. Then port 9 is open by a movement of the pilot

bit 1 upwards relative to the shank 2. Upon circulation of the drilling fluid, such as mud, an axial contraction force is applied and the bit tends to close thereby pushing the under-reaming arms 4 outwards. During rotation of the bit the under-reaming arms 4 will open the hole until the cutting elements 16 on the under-reaming arms 4 contact the steel of the previous casing installed already. These cutting elements should be designed such that they do not cut steel. This can be achieved for instance by using cutting elements with large negative rake angle similar to that applied for bi-centre bits.

While drilling out the cement from the casing shoe the under-reaming arms 4 scrape the cement from the inner wall of the installed casing or the bell area of the installed casing.

Once the under-reaming arms 4 extend into the open hole below the previous casing the cutting structure 16 will enable the hole to be opened up further to enable the arms 4 to reach their fully expanded position as shown in Figs. 2 and 3.

A design feature required for drilling-out of the casing shoe is that the pilot bit 1 is lockable in bit rotation direction relative to the shank 2 of the bit for any position of the piston 8. This can be achieved by extending the length of the lips 6 and the size of the flat sections 13 at the gauge of the pilot bit 1 so that they are engaged at all times. Alternatively the top part of tube 7 can be equipped with splines that slide in the top part of the shank 2 as to prevent rotation of the pilot bit 1 relative to the shank 2.

During the drilling-out of a casing shoe the drilling torque from the under-reaming arms 4 is transferred to

the shank 2 via the hinges 5. Alternatively the interface between the under-reaming arms and the pilot bit can be equipped with radial slots which transmit the torque from the arms 4 to the shank 2.

In summary, the invention provides an expandable bit, which can drill in several positions. In expanded position the under-reaming arms 4 are locked in place by a hydraulic force. Once the arms 4 are locked the drilling forces including the torque on bit and/or the Weight on Bit are transmitted directly from the cutting elements to the shank 2 of the bit thereby unloading the hinges 5 of the under-reaming arms 4. This way the bit is seen by the formation as a regular bit with a potential drilling capability similar to that of regular bits as well. This feature combined with the appropriate cutting structure on the under-reaming arms 4 should make the drill bit suitable for a wide range of formations including the harder rocks.

Among other features that can be included in the drill bit are:

- A gripping device for locking tube 7 once the arms 4 have has reached the fully expanded position by hydraulic actuation via the piston 8 and tube 7. This way the bit is locked in expanded position. At the end of a bit run the bit can be collapsed by pulling the drilling assembly into the casing again. This pulling force should enable shear pins that hold the gripping device to fail so that the tube 7 is released again and the bit opens and the under-reaming arms 4 can move to the retracted position.
- Nozzles 17 can be put in the pilot section 1 of the bit in such a way that the jets out of these nozzles 17 point towards the under-reaming arms 4 to provide effective cleaning and cooling.

- The expandable bit can also be used for conventional over gauge drilling with drill pipe rather than casing. In this case the shank of the bit is preferably provided with water ways to enable mud to be circulated while the arms 4 are in retracted position.
- Multiple sets of under-reaming arms can be included in the above described hydraulic locking-mechanism.

The hydraulic locking mechanism described above can be applied in a more general sense as well to achieve a specific functionality of other expandable down hole components, such as expandable stabilisers for application in over gauge drilling.

C L A I M S

1. Drill bit for drilling a bore hole in an object, the drill bit comprising a bit body extending around a central longitudinal axis, the drill bit being operable by rotation about the central longitudinal axis, the bit body comprising a central shank for connecting the drill bit to a drilling system, the drill bit further comprising a cutting arm provided with a set of cutters for cutting the object, the cutting arm being coupled to the bit body via pivot means via which the cutting arm is pivotable between a retracted position and an expanded position whereby at least in the expanded position the set of cutters is in a cutting position with respect to the object whereby cutting action causes a rotational torque between the cutting arm and the central shank, which drill bit is in addition to the pivot means further provided with support means for transmitting at least part of said rotational torque from the cutting arm to the central shank.

2. The drill bit of claim 1, wherein the support means is further arranged to support an axial compressive load from the cutting arm to the central shank.

3. The drill bit of claim 1 or 2, wherein the support means is further arranged to support a radial compressive load from the cutting arm to the central shank.

4. The drill bit of any one of the previous claims, wherein the support means is arranged to transmit a majority of the rotational torque, preferably essentially the full rotational torque, from the cutting arm to the central shank.

5. The drill bit of any one of the previous claims, wherein the cutting arm is additionally pivotable to an intermediate position, in which intermediate position a second set of cutters is arranged in a second cutting position with respect to the object for drilling a bore hole with a smaller gauge than in the expanded position.

6. The drill bit of any one of the previous claims, further comprising a pilot section provided with pilot cutters arranged for pre-cutting a pilot bore hole ahead of the cutting arm.

7. The drill bit of claim 6, wherein the pilot section is axially movable with respect to the shank whereby the cutting arm is coupled to the pilot section for controlling the pivoting of the cutting arm.

8. The drill bit of claim 7, wherein the pilot section is coupled to a hydraulic system for controlling said axial movability.

9. Bore hole tool usable within a bore hole formed in an object, the tool comprising a tool body extending around a central longitudinal axis, the tool body comprising a central shank and a tool arm, the tool arm being coupled to the tool body via pivot means via which the tool arm is pivotable between a retracted position and an expanded position whereby at least in the expanded position the tool arm is arranged for transmitting a force from the central shank to the object, which bore hole tool is in addition to the pivot means further provided with support means for transmitting at least part of said force from the tool arm to the central shank.

10. Hydraulic system for driving a pivoting movement of a pivotable tool arm between a retracted position and an expanded position, the hydraulic system comprising a cylinder and piston means slidably arranged in the

cylinder forming a drive chamber on one side of the piston means and a return chamber on the other side of the piston means, the piston means having a forward and a rearward position in the cylinder whereby the piston means is activatable to its rearward position by causing the drive force acting on the piston as a result of pressure in the drive chamber to exceed the return force acting on the piston as a result of pressure in the return chamber, which piston means is coupled to the pivotable tool arm for driving the tool arm from the retracted position to the expanded position when the piston is driven into its rearward position, whereby the piston means is coupled to gate means with is arranged such that the return force acting on the piston as a result of pressure in the return chamber exceeds the drive force acting on the piston as a result of pressure in the drive chamber when the piston means is in or near its forward position whereas the opposite is the case when the piston means is in a position other than in or near its forward position.

ABSTRACT

DRILL BIT AND SYSTEM FOR DRILLING A BORE HOLE

Drill bit for drilling a bore hole in an object, the drill bit comprising a bit body extending around a central longitudinal axis, the drill bit being operable by rotation about the central longitudinal axis, the bit body comprising a central shank for connecting the drill bit to a drilling system, the drill bit further comprising a cutting arm provided with a set of cutters for cutting the object, the cutting arm being coupled to the bit body via pivot means via which the cutting arm is pivotable between a retracted position and an expanded position whereby at least in the expanded position the set of cutters is in a cutting position with respect to the object whereby cutting action causes a rotational torque between the cutting arm and the central shank, which drill bit is in addition to the pivot means further provided with support means for transmitting at least part of said rotational torque from the cutting arm to the central shank.

~~T5 6003 EPL~~

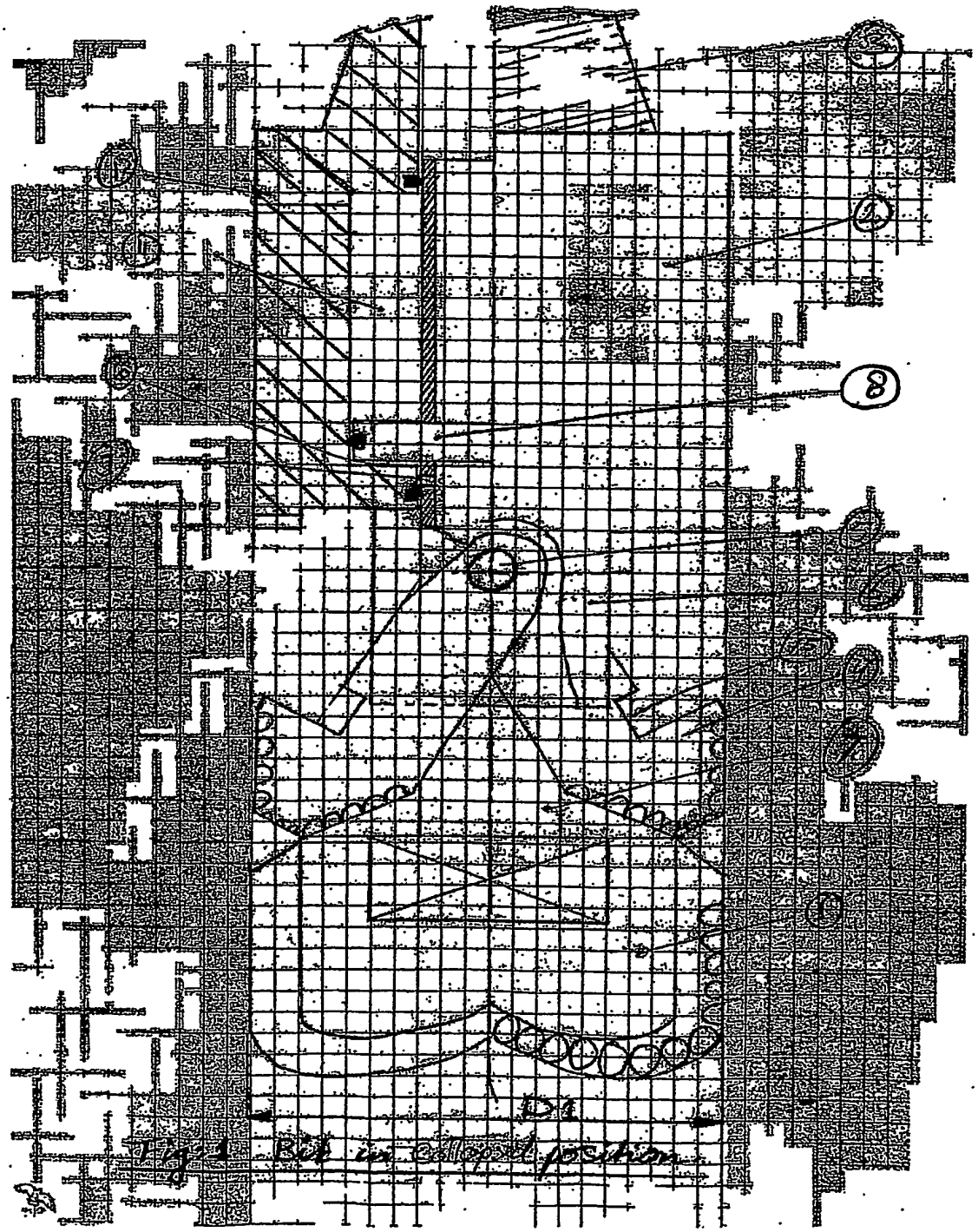

Fig 1 Bit in called position

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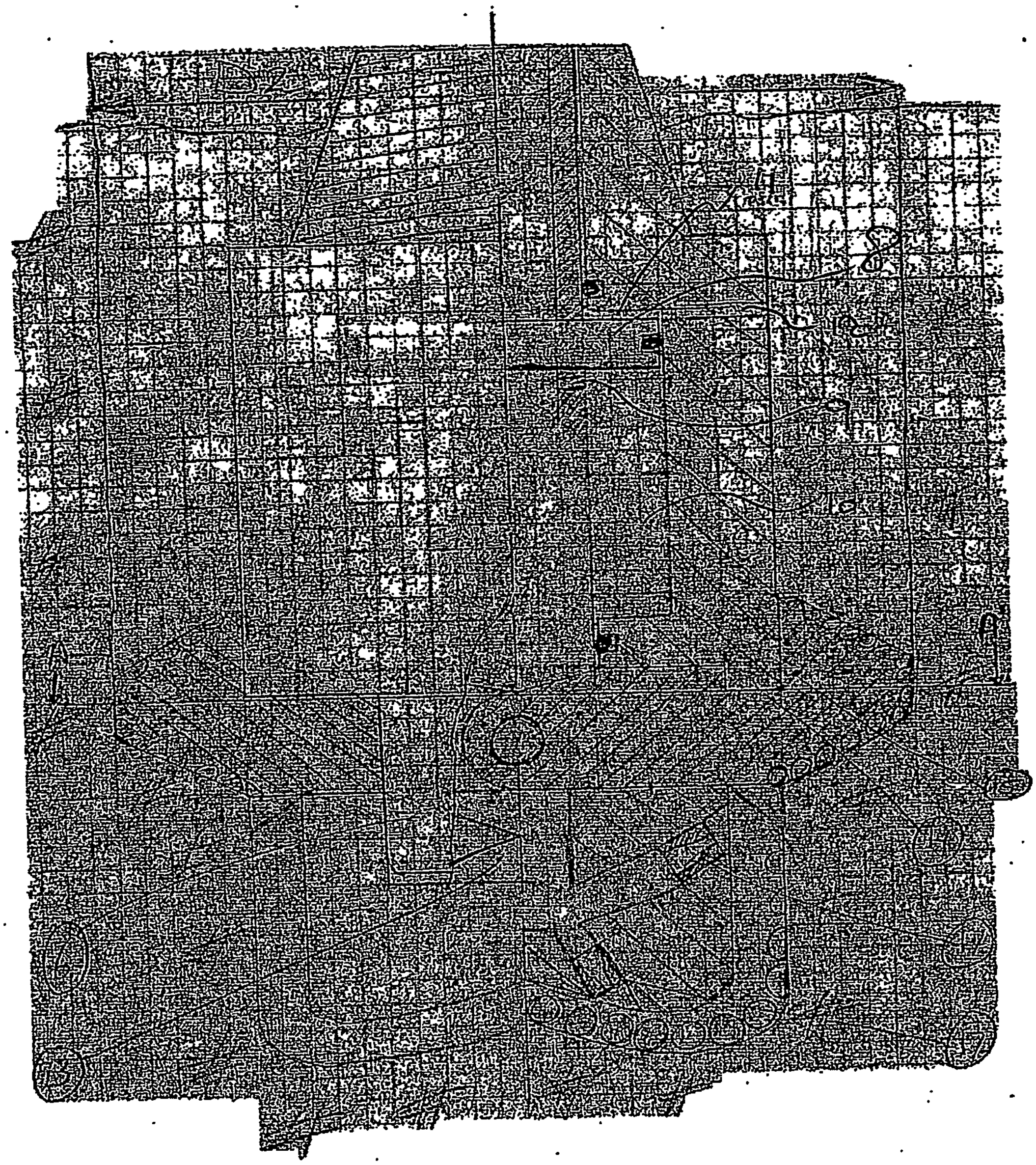

Fig. 25 Bolt in fully expanded position

T,5 bays EPL